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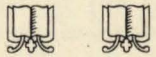
"Some Observations on the Regeneration of China and the Engineering Work Involved Therein"

AND

"The Functions of Both Pure and Applied Science in the Future Development of China"

BY

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With the compliments of the author,
J. A. L. Waddell.

TWO ADDRESSES

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ADDRESS No. 1

SOME OBSERVATIONS ON THE REGENERATION OF CHINA AND THE ENGINEERING WORK INVOLVED THEREIN.

Ladies and Gentlemen:

It was with great pleasure that I accepted the kind invitation of your Chairman to address this meeting of the representative intellectual youth of China; and I beg to thank your Board of Executive Officers for the fine compliment thus paid me. Your countrymen, like your illustrious neighbors, the Japanese, are truly a grateful and appreciative people, being quick to recognize good will and earnest effort on the part of those foreigners in Governmental employ who give wholehearted service in the country's interests. In my own case, although my term of service was only seven months, when I was in China I was made an honorary member of the two leading Chinese engineering societies and also of the Chinese Railway Association; and after my departure your Government conferred upon me the Second Class Order of Chia Ho, than which, I am told, no higher distinction in your country is attainable by any foreigner. While in each case I have endeavored properly and adequately to express my thanks and appreciation of the gift, I now desire once more and publicly to thank your Government and my good friends in China for these high honors and to assure both them and you of my profound appreciation thereof.

The subject of my address is "Some Observations on the Regeneration of China and the Engineering Work Involved Therein."

Perhaps you may think that, for one who has spent only half a year in your great and wonderful land, this is an ultra-ambitious subject to choose for a public address; and possibly you are right, but please remember the title's limitation is *"Some Observations,"* also that I am a man of years and experience, accustomed to handling large projects and to dealing with matters of importance. For these reasons I trust you will pardon my seeming presumption.

During my intensely interesting sojourn in your vast and ancient country, I spent all the time I could spare from my work in becoming acquainted with your leading citizens and officials, and in studying the social, ethical, and economic conditions, not only in your Capital, Peking, but also in the numerous cities, towns, and villages

where I stayed, whilst traveling officially over your railway system, and afterwards when visiting Southern China. It is true that I did not often wander many miles from a railroad; nevertheless in numerous conversations with highly intelligent and well informed persons I learned many things of importance concerning the interior of the country and the habits and customs of the Chinese people. My informants invariably appeared to open their hearts to me and to tell me plain truths, the reason probably being that they could not help perceiving the deep interest and sympathy I involuntarily manifested in my conversation. It is upon the strength of the information thus collected, as well as upon my personal observations, that I venture to address you concerning matters of vital interest to your country's welfare and her regeneration from the "Slough of Despond" in which, unfortunately, she is now struggling.

As both an engineer and an economist, my policy has always been *con*-structive rather than *de*-structive; hence during my stay in Peking I thought deeply and long concerning what could be done to correct the various evils I observed; but until just before leaving there I did not communicate my thoughts thereon to anybody. A farewell luncheon was given me by a number of the young Chinese gentlemen with whom in various ways I had been thrown in contact, at which gathering only a few Americans were present. While in most ways it was a very pleasant entertainment, it was nevertheless somewhat sad—certainly for me and apparently for some of the others—because I was about to bid adieu, possibly forever, to people whom I had learned dearly to love, and to whom I earnestly desired to be of service. I did not like the idea of then leaving China, because there were so many things of importance that I could have done for her, after having gained the confidence not only of the Ministry, but also of the educated people at the Capital. However, I had completed both the special work for which I had been called, and also a number of other technical tasks of great importance that had been set me to do; hence there was no reason for further delaying my departure.

Just as we were about to conclude the luncheon, and after the farewell toasts had been drunk, one young man arose and said, "Doctor, now that you are about to leave us, is there not some farewell message you can give us—some advice of importance that we can treasure, and which will be of benefit to our country?" To this question I replied in the affirmative, stating that I had had in mind for some time a scheme for the regeneration of China, which I had evolved after much deliberation, but which until then I had not ventured to bring forth because of its exceedingly drastic nature. Thereupon, I outlined to them the project which presently I shall suggest to this assembly.

All present seemed to approve of my recommendation; nevertheless I endeavored unsuccessfully then and there to induce my hearers to inaugurate the society I had described. Had I remained in Peking a month or two longer, I believe I might have started the movement and established the proposed organization upon a sound and successful basis.

A month later, whilst visiting Canton, I was urged by the officers of the Chinese Young Men's Christian Association to remain there an extra day, in order to give the members of that organization an address; and, although I had to let the others of my party proceed to Hongkong without me, I acceded to their request. The meeting was eminently successful, for I had a large audience and a phenomenally-fine interpreter, who translated all I said about as rapidly as I delivered it. My discourse was principally on the lines of political economy; although later, by special request, I dealt with a number of purely engineering subjects—mainly of local interest.

In my lecture I spoke plainly and without reserve, treating in detail the various economic subjects that in the present address I shall merely list. In spite of the fact that frankly and fearlessly I pointed out the principal shortcomings of the Chinese people and indicated how they will have to be corrected before your great country can take her legitimate place amongst the nations of the world, all that I said was accepted in good part, as was shown conclusively by the discussion which ensued.

Possibly my hearers were influenced by the same motive as were, some forty odd years ago, certain miners in West Virginia. I had been acting there for some months as engineer of a small coal mine; and in the course of my duties, I, personally, had broken up an incipient strike amongst the employees; and, whilst so doing, I had expressed myself very freely concerning the stupidity of strikers in general and those of our mine in particular. Soon afterwards, when leaving to take another position that was more to my taste, the proprietor of the mine remarked that the men were all sorry to have me go, and that I had become very popular with them. To this statement I expressed my surprise, remarking that I had thought they must surely dislike me on account of my plain speaking about the strikers. The proprietor answered: "Oh, no! They attribute that to your ignorance!"

It is conceivable that your countrymen at Canton whom I addressed "attributed to my ignorance" some of the rather uncomplimentary statements and drastic recommendations I made.

Certain of my American friends have warned me that in addressing you openly about the unsatisfactory condition of affairs in China (which, by the way, is now far worse than it was when my

wife and I were there two years ago) I may give offense, thus possibly losing the chance of being of further service to your country in the future after the existing clouds have rolled away from your political horizon. This is something, however, of which I must run the risk; for nothing of any account can be accomplished without plain speaking. If you could truly realize the great liking I have formed for the Chinese people and the deep interest I take in everything affecting the welfare of your country, I am convinced that not one of you would take offense at anything I am about to say; for, as previously indicated, the nature of my remarks is *con*-structive not *de*-structive—remedial rather than critical or censorious.

Whilst I am in every way a true friend of China, I must tell you that, for more than four decades, I have also been a true friend of Japan and the Japanese people, whom individually and collectively I hold in the highest esteem and affection—moreover, if you will pardon my apparent conceit, I would state that the liking is mutual. Of their friendly regard indubitable evidence is constantly being vouchsafed me; and this is truly one of the deepest gratifications of my life. The fact that I have been of effective service to Japan, and that I have a host of warm and appreciative friends in that country is one of the most satisfactory rewards that have come to me in the entire course of my professional career.

Owing to the phenomenal development of Japan and to the wonderful progress she has made in all lines of engineering, there is not much now that I can do professionally in her interests; but it is otherwise in the case of China, for in that country I can see numerous ways in which I could be of great service professionally—not only in the development of new work, but also in the correction of numerous engineering mistakes made in the past by engineers of foreign countries whom China, unfortunately, had employed. If there be formed in China, before the time comes for me to "pass on", a stable government having the desire to accomplish the maximum of good for the entire country, I hope, as do also numerous Chinese friends of mine, that my services and advice will be sought and utilized.

And now, after all this preliminary palaver, which I trust has been neither tedious nor uninteresting, let us pass to the first of the two topics which my address is aimed to cover, viz:

A SCHEME FOR THE REGENERATION OF CHINA.

The prime essential for establishing China in her proper place amongst the great nations of the world is a stable federal government, conducted on sound ethical and economic principles. This,

however, would not prove a panacea for all the ills with which that country is afflicted—far from it!—because there are requisite many improvements in conditions that would have to be effected by the governments of provinces and municipalities, by universities, colleges, and schools, by corporations, and by individual Chinese.

This address will deal at length with the first-mentioned desideratum, for the reason that, until it is consummated, nothing permanent or adequate can be accomplished in respect to the solution of the other necessary ameliorations.

A stable and satisfactory government cannot be formed in a few weeks or months—or even years; for, in a vast country like China with its numerous and widely-differing races of men, an immense amount of hard work will have to be done, in order to bring the conflicting elements into line. This is certainly a stupendous obstacle to overcome; but there is one still more difficult, viz., the abolishment of official corruption, or, as it is variously termed, graft, boodle, or squeeze.

China, unfortunately, is by no means the only country where this evil exists, but it is developed there to the nth power. In some countries it is frowned upon by all decent people; in others (when detected and proved) it is punished by fine or imprisonment, or both; but in China it is regarded as almost an established institution, and while a few of the prominent men condemn it, nevertheless they suffer it to exist on the plea that it is a necessary evil, ingrained in the ruling classes—and even in civil life. Until this obnoxious condition of affairs is overcome, there can be no valid hope for the fundamental regeneration of China.

The important question is how this vital requisite can be effected. Many people say it is an impossibility, but such is not the case; for anything within reason can be accomplished, provided that sufficient earnest and continued effort be devoted to the undertaking.

What, then, can be done effectually to eradicate graft in China and to establish a stable government honestly and economically conducted? Evidently, a change of heart on the part of the educated Chinese is essential before any fundamental modification can be established in the *modus operandi* of the government. To secure this it will first be necessary to influence the younger generation, for the old saying is true that "it is hard to teach an old dog new tricks"; and the most promising amongst these younger men are the students newly returned from abroad. They generally come home full of enthusiasm and imbued with the patriotic desire to improve conditions in their country; but only a few of them are able ultimately to resist the overwhelming discouragement of inertia and the pressure of established custom that continually urges them to "do in Rome as

the Romans do." Most of them eventually succumb to such pressure and to oft-proffered temptation; and, once fallen, recovery is almost an impossibility.

If, then, the rehabilitation of the government is dependent primarily upon the returned students, they must be reached and enthused at once before being contaminated by their surroundings. One reason why so many of them fail to retain their high ideals of right and justice is that there has hitherto been no co-operation between them, each one having to resist temptation unaided. If there were an organization, based upon equity and ethics, to band them together and to sustain them in individual right-doing and in patriotic service, they would have a far better chance of maintaining permanently their integrity; and such an organization could be used as a nucleus for the rehabilitation of the country.

Let there be formed, then, in either Peking or Canton, a small society, mainly of returned students, but also including any educated and enthusiastically patriotic Chinese who possess established reputations for integrity, the avowed purposes of the said society being the establishment of an honest and economic federal government upon a permanent basis, and the general development of China. Let this nucleus expand carefully, but as rapidly as possible, so as to include practically all the eligible men in the city and its vicinity—*but no others;* and as soon as the parent organization becomes firmly established and flourishing, let there be instituted chapters in other cities of the Republic (both North and South), and let this policy of expansion be continued until the entire country is covered.

The Society should have an elaborate constitution, expounding in full detail its aims, objects, and methods of operation; and each member admitted should be bound by the most solemn and effective oath that can be evolved, pledging him to personal uprightness and integrity, to the forwarding of the Society's legitimate purposes, and to co-operation in all of the organization's official undertakings. Blind adherence to the decision of the majority in all cases, however, should not be insisted upon, if such adherence would force the individual to a course of action of which his conscience disapproves.

Let the aims and objects of the Society be made known to the world; and let its Constitution and By-Laws be published from time to time in all the important papers of the Republic; but let the meetings be held behind closed doors, and let all the business of the organization and its doings be considered, to as great an extent as possible, strictly confidential amongst the members. Unless this be done, the adversaries of the Society's objects will be able to thwart some of them. It might be well, however, in order to avoid claims of undue secrecy, to publish the proceedings of the Society in rela-

tion to any important undertaking, but not until after the said undertaking is a *fait accompli.*

Until any chapter has become successfully established, it would be well to keep its membership secret, and not even let the public know that it is in process of formation; but afterwards an open policy should be adopted. In order to make known the membership in any of the fully-established chapters, each member thereof should wear the badge of the Society on the lapel of his coat; and that badge should be of a most distinctive character. At first this action might prove an inconvenience, owing to the enemies it would probably make for the individual amongst the opponents of good government; but after a few years the badge inevitably would prove to be an honor and a distinction in the eyes of the general public.

The greatest of care should be taken in the selection of new members, not only in order to keep up the reputation of the Society and the high standing of its personnel, but also to exclude spies; because a single spy might be able to cause great trouble by furnishing to the enemies of good government information that would enable them to block important undertakings.

It would be necessary to adopt a telegraphic code and to change it from time to time, so that messages of consequence could be sent without danger of divulging their import.

If at any time any member be found guilty of violating his oath of membership, or of conduct unbecoming a gentleman, or that would lower the high ethical standard of the Society, he should be expelled; and notice of his expulsion and the cause thereof should be published in all the principal newspapers of the land. The disgrace infallibly attendant on such expulsion would serve as a strong deterrent against improper conduct.

The formulating of the aims and objects of the Society is an important matter demanding much thought and consideration on the part of the charter members; and the list thereof should be full and complete. It might well include most, if not all, of the following:

A. The suppression of graft in all its forms, not only in the Federal Government, but also in the governments of provinces and municipalities.

B. The selection and putting in office of honest, educated, capable, and patriotic men, and the exclusion therefrom of all candidates who do not possess these qualifications. At first it would be necessary to select candidates from men who do not belong to the organization; but as the latter becomes firmly established, and as its members mature and develop in experience, the reverse policy should be inaugurated. Eventually in this way the Society would become the real ruler of the country and the director of its destiny.

It would be a suicidal policy for the organization to use its power for the purpose of putting its members in office solely to give them employment, when they are either unfit for the work to be done or inferior to other available men outside of the Society's ranks.

C. The encouragement of the practice of true economy in all governmental and municipal affairs.

D. The establishment of low-grade schools for the masses, so that in a generation or two everybody will be able to read, write, and figure; trade schools for artisans; commercial schools for business men; colleges for those of literary and artistic tastes; and high-grade technical schools for those capable of studying either pure or applied science.

E. The study in China of world politics, and the development, on a systematic basis, of a thoroughly-trained diplomatic corps.

F. The suppression of superstition and fear in the minds of children and uneducated adults.

G. The disbanding of the military and the substitution therefor of a National Police Force of great efficiency on the lines of the Canadian Mounted Police.

H. The suppression of harmful or pernicious practices, such as organized begging, the binding of female children's feet, plurality of wives, abnormally large families, and the use of opium or other habit-forming drugs.

L. The study and development of sanitation in all lines, including water-supply, sewerage, proper use of fertilizers, and the extermination of all disease-carrying vermin, such as mosquitoes, house-flies, bedbugs, lice, rats and mice with their parasitic bubonic fleas, and the hookworm—also the installation of sanitary public baths and the promotion of bodily cleanliness.

J. The endorsement and assisting of all great public enterprises that would advance the interests of the nation, such as railways, motor highways, common roads, drainage, bridges, canals, harbors, river conservancy, irrigation, internal navigation, merchant marine, storage of water, power development (both hydro-electric and by burning coal at the mouth of the mine), afforestation, mining of all valuable ores that exist in sufficient quantities to warrant development, wireless telegraph and telephone systems, aeroplane service, and manufacturing, in all paying lines, for both home consumption and export.

K. The establishment of a practicable credit system for the business of the country, and making possible the borrowing, both at home and abroad, of money for laudable enterprises at reasonable rates of interest.

L. The establishment of a single system of currency, upon either a gold or a silver basis, for the entire country, and the abolishment of all other money systems.

M. Universal cremation of the dead, and the taking over of all old grave-yards for agricultural purposes, also the utilization of absolutely worthless land, such as rocky hillsides, for the closely-spaced depositing of the ashes of those cremated.

N. The codification of a system of federal laws best suited to China's needs and based throughout on equity and justice.

O. Mutual brotherly help for every member of the Society on the part of all the other members. It is not contemplated that membership therein should involve either martyrdom or undue personal sacrifice. Every member thereof should be entitled to a good, comfortable living; and his compensation should be commensurate with his ability and energy. In other words, he should be paid all his services are worth, plus his share of the Society's dues—but no more; because, while it would be perfectly proper for the organization to ensure adequate compensation for its members, it would be contrary to its aims and objects to demand anything materially in excess thereof.

The question of financing the Society, so as to enable it to carry on its undertakings, is one of serious import, and should be given at the outset due consideration. Uniform annual dues would hardly suffice; hence it might be necessary to call for each member to contribute a certain percentage of his gross income. Possibly, financial aid could be secured from rich merchants, bankers, manufacturers, and capitalists—not merely on patriotic grounds, but because a stable government and the general development and welfare of the country would augment their gains and render secure their holdings.

Some of the funds of the Society would undoubtedly be required from time to time to help members who are in unavoidable want; and this should be considered legitimate expenditure. Each chapter would need a well-paid secretary and a few clerical assistants; and much money would be required for printing propaganda, postage, telegraphing, and traveling. Beyond such items as these, however, the expenditure should seldom pass, because further spending might border on the illegitimate.

Finally, in respect to the form of oath for each member to take when joining the Society, it should be made as comprehensive as possible, so that, in every case, at least one of its items would be binding. The following form is suggested:

I, the undersigned, in joining the..... Society, hereby pledge myself to keep free from graft of all kinds;

that I shall never accept, give, nor offer a bribe of any description, either directly or indirectly; that I shall lead an honest and upright life; that I shall adhere strictly to the rules and regulations of the organization; that I shall consider and treat each member thereof as a blood brother, aiding him in every legitimate manner to accomplish his laudable purposes and even helping him financially, if he be in dire need, as I would were he a worthy member of my own family; that I shall do all in my power to further the official undertakings of the Society; that, unless my conscience, for good and sufficient cause, dictate the contrary, I shall vote for all public-office candidates endorsed by the Society and shall do my utmost to aid in their election; that at all times I shall uphold the organization and endeavor to augment its power for the accomplishment of good; and that my main objects in life shall be the regeneration of China and the advancement of her true interests—and this I swear by

a. My honor as a Chinese gentleman.
b. The religion which I profess.
c. My hope for a happy existence after death.
d. The ancestors I revere.
e. The descendants whom I hope to have in generations to come.

Undoubtedly many of you are now thinking that this "scheme" of mine for the regeneration of China is ultra-altruistic, chimerical, impracticable, or even utterly impossible of achievement. If such be the case, I beg fundamentally to differ with you; for almost nothing is impossible of accomplishment these days, provided it be undertaken by the right kind of people with a firm determination to succeed in spite of every obstacle that may arise. The old motto "never say die while there is a shot in the locker" should be the watch-word in any such undertaking; and if it were strictly obeyed at all times, success would surely be ultimately achieved.

It is possible that some of the initiators of the suggested movement would suffer inconvenience, loss of property, bodily injury, or even death; but in the latter event the suffering individuals would be martyrs in a just and worthy cause, and their memories for many generations to come would be enshrined in the hearts of their countrymen. But, if the matter were wisely and properly handled, no such dire eventuality as violent death should be involved. Danger thereof could result only from irresponsible enthusiasm and reprehensible lack of caution on the part of some of the youthful members of the organization. That, from time to time, apparently insurmountable difficulties would arise goes without saying; but patience and perseverance most assuredly can overcome every obstacle. History gives many proofs of the correctness of this statement.

Strictly speaking, the people of China are not yet ready for a republican form of government; because universal education is a prime requisite therefor, and, as you well know, a very large proportion of the population of your country is illiterate. This is their misfortune—not their fault; and it is a defect that could readily be corrected in one or two generations, as is evidenced in Japan, where the percentage of illiteracy today is almost zero.

In spite of my rather limited sojourn in your country, I reached the firm conclusion that, while the masses of the Chinese people are illiterate, they are, notwithstanding, exceedingly intelligent and mentally alert. This indicates their capacity quickly to absorb learning and to accommodate themselves to new and improved conditions of living. They are a law-abiding, kindly, and courteous people; and their civilization does not need as many modifications as most foreigners seem to think. For my part, I deem it a mistake to try to force upon them the Christian religion; as they have religions and ethics of their own which are just as satisfactory and serviceable as Christianity. It is not a greater amount of religion that the entire world needs in these days of social upheaval and mass unrest, but more of ethics, education, and common sense! It seems to me that the Great War has not had the effect of bringing the nations into a condition more favorable than previously thereto for the general establishment of democracy—but just the reverse! Most of the peoples of the world today need the firm rule of dictators like Mussolini of Italy or even like Diaz of Mexico, in spite of some of the high-handed measures he made a practice of employing.

If I may be permitted to give my personal opinion on the matter, what China requires today more than anything else is a broad-gauge, altruistic, unselfish, but firm dictator, who would whip the discordant factions into line and repress all aggression and unwarranted local assumption of power by men of militaristic tendencies. * * * * *

And now let us pass to the second division of my subject, viz.:

THE ENGINEERING WORK INVOLVED IN THE REGENERATION OF CHINA.

As it is now-a-days almost universally conceded that the progress of the world is primarily due to the work of its engineers, it is evident that the members of the engineering profession in China will be steadily occupied, whilst her regeneration is being effected. As their number is comparatively small, there will be far more work than they can possibly do without aid, hence the Government will

have to look abroad for technical help; and, for the following reasons, it is to this country that it should turn:

First: The engineering constructions required in China are much more like those of America than they are like those of Europe.

Second: As China has no money to waste, it is well to employ engineers who are accustomed to the application of the principles of true economy in their designs and constructions—and American engineers, as a class, excel in this particular.

Third: China in times past has so often suffered seriously from the inefficiency and lack of ability of certain European engineers, and has had, in general, such good satisfaction from the few American engineers she has employed, that it is now advisable to allow Americans an opportunity to give evidence of their practical technical ability and economic skill.

Before, however, any systematic work by the engineers can begin, many important financial questions will have to be solved. China has not sufficient funds to carry on great works of construction, consequently she will have to borrow money abroad; but, before doing so, she must have a sufficiently-stable government to warrant the people of other countries in investing their savings in Chinese securities. Be it remembered that it is neither the Government nor the bankers of any country who would make loans to China, but the common people thereof, as these buy the bonds from the bankers through the intermediation of brokers. If the said common people are averse to lending their spare cash on any proposed security, the bankers are powerless to advance the money from their own private funds, which are, comparatively speaking, of small amount; hence it behooves a borrowing Government to establish a satisfactory financial reputation among the citizens of any country from which a large loan is desired.

At present the United States of America possesses the great bulk of the world's supply of gold, as well as notes (amounting in value to many billions of dollars) from European countries for moneys advanced during the world war; hence it is to this country that China must turn for funds as soon as she is successful in putting her house in order. The necessary money will surely then be forthcoming, for the reason that the Chinese Government has long had an established reputation the world over for always eventually paying its debts; and that reputation will stand it in good stead later on, in spite of your country's present inability to meet her financial obligations.

To re-establish her somewhat impaired credit, it would not be necessary to return immediately all outstanding loans, but merely

to pay all accrued and current interest thereon and arrange some satisfactory means for future cancellation. America needs only some substantial indication of China's intention to pay her foreign debts, before agreeing to advance capital for legitimate enterprises calculated to forward the rehabilitation of your country.

The principal present necessities of China in which engineering is involved, arranged approximately in the order of their importance, are as follows:

Railroads
Arterial Motor Highways
Common Roads
Drainage
Bridges
Agriculture
Water Supply
Sewerage
Telegraph and Telephone Systems
Manufactories
Aeroplane Service
Structural Steel Shops
Creosoting Plants
River Conservancy
Internal Navigation
Irrigation
Afforestation
Power Development
Electric Lighting
Harbors
Mining
Metallurgical Works

The preceding listing of the various engineering works, as before stated, is approximately in the order of their importance, but this order is, unavoidably, imperfect. You must understand that I do not advocate starting and continuing the constructions exactly in the order named, for many of them must proceed simultaneously; but the division of the total funds available for engineering constructions should, for a while, be based somewhat upon the importance of the works as above listed. For instance, railroads are needed at once for several reasons of importance:

First. It occurs occasionally that thousands of people in a certain district are dying from starvation, while, in another part of the country, there is plenty of food, it being absolutely impracticable

to transport supplies from the one district to the other over the existing routes of travel.

Second. As an economic matter, it is essential that the products of the interior, both raw and manufactured, be readily and cheaply transported to points whence they can be sent by water to foreign countries.

Third. Business in general is greatly facilitated by making possible the quick passage from one place to another of those concerned therein.

Fourth. In the event of an uprising or other political disturbance, railroads are necessary for the rapid transportation of troops.

The most needed piece of railway line in China today is that for filling the gap of some 280 miles between Wu Chang and Canton. With this completed and the two bridges at Hankow, mentioned later on, constructed, it would be practicable to make the journey between Peking and Canton in two days, while at present it requires two weeks by combined rail and water routes. A quick means of travel between Northern and Southern China is essential for the maintenance of the integrity of the Republic; and I venture to say that, had the gap referred to been filled a few years ago, there would have been no secession of Southern China.

The next most needed railway line is one starting from Hankow and running westward into the thriving province of Szechwan. It is said that such a line would serve a population of sixty million people and open up a rich district that is now almost isolated from the rest of the world.

When one considers that China has only seven thousand miles of railway, while the United States, a country of about the same area, has two hundred and fifty thousand miles—and is today wanting more—it is evident that railway building is a vitally important matter for the welfare of your country. Certain railroads are needed immediately as main arteries of travel; and to feed these certain first-class highways are required for motor vehicles; and from the said highways should extend common roads of cheap construction for horses, camels, carts, and pedestrians, but sufficiently well built and maintained to be passable at all seasons of the year.

A thorough system of drainage is requisite for all railroads, arterial highways, and common roads. Such drainage is quite inexpensive in a country of cheap labor; and it is the most important economic feature in the up-keep of all routes of travel.

The reason why I have placed bridges so near the head of the list is not because I specialize in that line of engineering, but because they are a necessary adjunct to roads of all kinds.

China in the past has been exceedingly unfortunate in the designing and construction of her railway bridges, having had to entrust the work to foreign engineers, and, in so doing, having generally made bad selections. Every bridge on the Kin-Han railway, aggregating about seven miles in length, will have to be either materially strengthened or removed; for not one of them is half strong enough to carry with safety the train loads that, for the sake of economy, should be adopted. Before my arrival at Peking, two of these bridges had failed under load, and others had been wrecked by washout, owing to defective design of substructure and to unstable foundations. The first task allotted me by the Ministry of Communications was to report upon how to utilize the metalwork of all these bridges. As many of the spans were alike, I indicated how to combine two truss-bridges into one, and three plate-girder bridges into two, thus saving practically all of the old metal.

A late report by a Chinese engineer shows that all the bridges on another important line of railroad are incapable of carrying a live load exceeding the American standard loading E 13, indicating a maximum load of 13,000 lbs. on an axle, and a train load not greater than 1,300 lbs. per lineal foot of track. When I tell you that a load four times as great as this would be considered today in this country as too small for any first-class line and none too great for the designing of bridges on second-class lines, you will understand how utterly weak and unsafe are the railroad structures over which your countrymen ride every day, and to what extent their lives are thus endangered. While I can speak from personal experience concerning the bridges of only the Kin-Han line, I greatly fear that practically all the railroad bridges of China will soon have to be either materially strengthened or replaced.

As for new bridges of importance, there are a few that are needed as soon as they can be financed and constructed. I reported to the Government concerning two of them at or near Hankow, one over the Yangtse and the other over the Han. My report on these proposed structures was published in the July, 1922, number of the Journal of the Association of Chinese and American Engineers. These structures, which should carry both railway and highway traffic, are urgently needed, first, in order to connect the great railway systems of North and South China, and, second, to facilitate highway travel between the three cities of Hankow, Han Yang, and Wu Chang; because, when the wind blows hard there, it is impracticable for the people of those cities, having an aggregate population of nearly two millions, to cross the larger of the two rivers.

I reported also upon a proposed bridge to cross the Yangtse River between the cities of Nanking and Pukow, but my finding was adverse to the project, because there is no real demand for the struc-

ture—besides, its estimated cost of about twenty million Mexican dollars would be prohibitory. In my opinion, such a bridge will not be required in the next one hundred years—if ever.

There is a real need for a combined railway-and-highway bridge across the Hwang-pu River at Shanghai. When I was there in 1921, by request of certain prominent residents, I determined the best location for it and the proper type of structure to adopt, but made no written report upon the project.

Other important bridges will be wanted in the near future by various seaport cities; and all new railway lines will involve the building of numerous structures for the crossing of rivers, streams, and gorges; hence it will pay Chinese engineers to devote considerable attention to the study of bridge designing, including substructure as well as superstructure, because the piers of many of the existing bridges are inadequately founded.

Incidentally I might mention that, when I was in Peking, I designed a new type of long pile to be driven by water-jet, to meet the peculiar conditions of the beds of the rivers of China where they cross the great alluvial plains. The use of this pile will so cheapen the construction of the piers as to make deck, plate-girder spans the economic type of superstructure, and thus will effect a very large saving in the cost per lineal foot of bridge. My report on this pile design was published in the August, 1922, number of the Journal of the Association of Chinese and American Engineers. Owing to the fact that no construction work has been done on the Kin-Han Railway since the report was written, the pile has not yet been given a trial; but my good friend, Mr. C. S. Wong, the Chief Engineer of the line, intends to employ it on the first opportunity.

You may think it odd that I have included agriculture in the list of engineering items; but truly today agriculture, as practiced in the most approved, scientific manner, is a branch of engineering; and it is beginning to be classed as such in our universities.

The soil of China is overworked, and the methods of its culture are generally crude and antiquated. The Government gives the agricultural class very little aid and practically no instruction, all thereof that the farmers have received having been provided by the Christian missionary colleges.

In proof of what practical science can do for agriculture, let me tell you that the instruction given to farmers by the University of Wisconsin in a very few years actually doubled the agricultural product of the State. This clearly indicates what a proper system of instruction in agriculture could accomplish for your country.

There is a crying need throughout China for an adequate water

supply for the entire population, excepting only in the richer portions of a few large cities. The poor (and most of the people exist in dire poverty) have to purchase their water in exceedingly small quantities from peripatetic vendors at necessarily-high unit prices. They secure in that way barely enough for drinking and cooking purposes; hence the facilities for bathing and personal cleanliness are extremely meagre. As cleanliness and health are closely allied, and as a supply of fairly-pure drinking water effectively cuts down the ravages of typhoid and other kindred diseases, it is evident that "Water Supply" is a most important branch of engineering for your country.

Sewerage, in the true sense of the word, is something almost unknown in China. Its development is a necessity for the health of every community; but the American and the European methods of effecting it are not applicable to China, where the sewage must be saved for fertilizing the soil, and not wasted by being discharged into the water courses. This line of engineering, therefore, requires special study; and the Chinese engineers can do all the work involved with very little aid from their foreign brethren.

In this connection permit me to quote the following from a late report of "Engineering Foundation," entitled "Humus from Garbage —Inoffensive Waste Disposal":

"For generations, men have sought to return to the soil some of the nutriment taken from it. In the main, Man's organic wastes have been lost, especially from communities. Indeed, they have been a nuisance or a menace unless destroyed. Often they have been removed long distances only to pollute streams, harbors, or idle land. Science and engineering have offered many methods for disposal of sewage, garbage, and other wastes. One of the problems has been to devise simple, inexpensive, and safe means suitable for small communities, institutions, or single families, yielding an inoffensive and useful product. High cost of fertilizers, caused by the war, gave new impetus to endeavors in some European countries.

"A few years ago, an Italian scientist, who had worked on the problem for a long time, Giuseppe Beccari, discovered that in a properly constructed cell of cement concrete or other tight masonry, natural processes of fermentation could be so controlled and expedited as to reduce kitchen waste, animal carcasses, grass clippings, fallen leaves, stable manure, and human fecal matter to humus without disagreeable odors or other offensive features. No fuel nor chemical is required. Aerobic bacteria do the work. All disease germs of man, beast, and plant, all weed-seeds and parasites are destroyed. Gustavo Gasparini and other scientists have confirmed by extensive tests the

results gotten by Dr. Beccari. The zymothermic cells are in practical use in a number of places in Italy.

"After a cell has been filled, the temperature begins to rise on the third day, and in a comparatively brief time attains 140 to 150 degrees Fahrenheit. Maximum temperature, between 150 and 160 degrees, is reached about the tenth day, holds nearly constant for 20 days, and then falls slowly. Fermentation is complete in from 35 to 45 days, depending on atmospheric conditions and the nature of the wastes. By the 35th to the 45th day, the product is sufficiently cooled to be drawn out to a bin in front of the cell, or other convenient place, where, exposed to sunlight, the excess moisture dries out. The product then resembles loam. Bones, objects of metal and ceramic wares are not affected; they are removed by screening. Of course, it were better to keep them out of the garbage in the beginning, particularly tin cans and broken crockery. Carcasses of animals are reduced to skeletons (entirely free from flesh and cartilage) and a small humid mass. At no time during the process is there odor of putrid flesh.

"The inoffensive black humus yielded by the cells may be used as an enricher of the soil, restoring some of the properties taken out by crops. It is a good fertilizer, containing nitrogen, phosphate, and potash.

"Each cell is an approximately cubical masonry box of from one to 25 cubic yards' capacity, according to requirements of each installation. Larger plants are made by grouping cells in series. Each cell has a double floor, the lower one watertight, and the upper, a concrete grating. Through the outer wall, between the two floors, are air inlets. In the four interior corners are vertical air ducts with openings at regular intervals connected with horizontal air passages formed by ridges on each wall, projecting a few inches. All these airways, and the space at the top of the cell, over the charge of wastes, connect with a specially-constructed ventilation-tower surmounting the cell and having openings to the atmosphere. Wastes are put in through an opening in the top of the cell. The product is removed through a large opening in the front wall controlled by a tight door. The liquor from the charge during fermentation is collected by drains from the lower floor into a pit. This liquor contains many of the bacteria of fermentation and is used for wetting new charges, so as to assure and expedite the beginning of the process. The exact form and arrangement of the cell was determined by years of experimentation.

"Although an outgrowth of the compost heap, common in gardens for centuries, the zymothermic cell is a product of scientific research and engineering design. Success appears to be due in large measure to the arrangement of air passages which distribute air to all parts of the contents of the cell."

I have quoted this report *in extenso* because of the peculiar appropriateness of Dr. Beccari's invention to the conditions existing in your country.

Telegraph and telephone systems are needed throughout the entire Republic, not only to facilitate business, but also to keep the Central Government cognizant of everything affecting the welfare of the various provinces and thus enable it quickly to put down uprisings.

The development of manufactories of numerous kinds is an important line of activity for China, because such works would keep steadily occupied on paying business a lot of people who are now tilling an already-overworked soil. The earnings of the workers in manufactories could be utilized for importing more food into the country, thus giving the farms a chance to recuperate. China should endeavor to manufacture all the spare raw material she produces and much imported raw material besides, so as to keep steadily occupied a lot of the country's now unemployed men and women, and thereby increase the general wealth of the nation through the sale abroad of a portion of the manufactured products. By the resulting increased industry of the people in general, the national wealth would be augmented, and the comfort and happiness of the masses substantially improved.

Aeroplane service is somewhat in the nature of a luxury in this country and in Europe; but, for many years to come, it would be anything but that in China, because important mail could be thereby delivered in distant portions of the Republic not reached by railways or arterial motor highways. The Government already has at Peking a school of aviation, established in 1921 under the direction of a good friend of mine, Capt. Carl Dolan, one of the most noted "aces" of the late war, who served first in the French and afterwards in the American Army. This school should be enlarged so as to train the aviators who would be required for the suggested aerial mail service.

Structural steel shops would be a boon for China and would save the expenditure annually of large sums of money for imported manufactured metal. With enough of them properly equipped and managed, China could manufacture nearly all the steel bridges and buildings that the country needs. At first it would be necessary to import the rolled metal, but later iron ore could be mined and smelted, and the resulting pig iron converted into steel and rolled into billets, plates, and shapes—all in China.

Creosoting plants are an economic necessity in your country, because you have to import railway ties and other timbers at great expense. In order to make these last as long as possible, it is necessary to creosote them or otherwise preserve them; and this can be done to better advantage at home than abroad.

River conservancy is one of the most important lines of engineering work for China; but, alas! it requires far more capital than can be raised for many years to come. The fact that often multitudes of your countrymen are drowned or have their homes and farms destroyed by the overflowing of your rivers indicates the necessity for an elaborate system of land protection. Whilst waiting for the money for such construction to become available, a sufficient sum should be spent on the study of the engineering problems involved, so as to prepare all plans, specifications, and estimates for the work in advance of the time when they will be needed.

Internal navigation and river conservancy work should go hand in hand, for whilst protecting the lands from overflow by confining the streams to their legitimate bounds, their channels could be deepened for vessel traffic.

Irrigation, too, is closely allied with river conservancy, and should be developed to the utmost in China wherever there is a scarcity of water for agricultural purposes. As that branch of engineering has been scientifically studied by our Western engineers, the Chinese members of the profession would do well to come to this country to learn the *modus operandi*. Irrigation is practiced on a large scale in India, hence it might be well to look to that country also for instruction therein.

In respect to afforestation, which is sadly needed all over China, it would be well to turn to the Japanese engineers for assistance, as they are the most expert and successful people in the world in the matter of tree planting. Throughout the whole of Japan and in many parts of Korea large artificial forests can be seen—and almost always they are in a thriving condition.

In order successfully to build up any forest, it is absolutely necessary to let the fallen leaves and twigs lie upon the ground to form a humus; but this the Chinese peasants seem unwilling to do. Every leaf that falls is garnered for fuel, the result being that your few tree-plantations do not thrive. The humus would retain moisture, thus tending to nourish the trees through dry seasons; and the resulting holding back of rainfall from the water-courses would reduce the violence of their floods.

Timber is a scarce and expensive commodity in China, therefore its production should be encouraged to the utmost, and its waste should be prohibited. Enough fine wood is annually absorbed for bulky and elaborate coffins to provide useful furniture for a large portion of the population. The living should not suffer from imaginary needs of the dead; and to permit this is a glaring violation of the principles of true economy.

Power development is feasible in certain parts of China that are not too remote from the large centers of population. It can be accomplished either by harnessing the energy from water-falls or by burning coal at the locality where it is mined, so as to avoid expensive transportation. I did not see many places where water-power was being wasted; for most of my traveling was done on the vast alluvial plains of your country. Much to my regret, I was unable to make a trip up the Yangtse River above Hankow, owing to the upset condition of the populace; for I desired to look over the rapids of that great water-course and see whether it were feasible to adopt a certain scheme I had conceived for making the river supply the energy for towing boats against its current in the rapids. Much power is undoubtedly now going to waste at the said rapids; but sooner or later it is sure to be utilized.

Some of you may consider electric lighting to be more of a luxury than a necessity for a country in China's present condition; but experience has shown its use to be an economic innovation wherever it has been produced with reasonable expense. Where water power is closely available, as in Japan, electric-light plants have proved to be an economic boon; and it is found that electricity year by year is being transported greater and greater distances. As a case in point, I believe that power developed at the rapids of the Yangtse River could advantageously be carried to the before mentioned three great cities located at the mouth of the Han River, thus serving a population of nearly two millions.

China needs more good harbors; and, as her products increase in amount and value, more ports will be required for their shipment abroad.

It is said that there are great undeveloped mining possibilities in China, but this report has been contradicted by certain men who claim to be mining experts. Be this as it may, the mineral deposits of the country should be thoroughly explored by competent geologists, mineralogists, and miners; and whatever resources of commercial value are found should be properly developed. The production at

home of metals and other mine-products would reduce the amount of imports of these materials from abroad, and thus tend to turn the balance of trade towards China. A comparatively large sum of money could, therefore, be economically expended by the Government in a systematic search for mineral wealth of all kinds, and in its exploitation after having been found.

With the development of mines there would naturally result metallurgical works for smelting the ores; and the building of such smelters would involve some important occupation for engineers.

There are other lines of engineering of lesser importance, too numerous to mention, that sooner or later will make work for the technical men of China.

His Excellency, Dr. Sao-Ke Alfred Sze, the Chinese Minister to America, has suggested to me that I include in this address some "guidance and advice as to what students of engineering should do on their return home, and also later in their profession." To do this would require more time than that allowed me for this entire address —moreover, many of you are not engineers nor are specially interested in engineering matters. However, I can very fully comply with the spirit of Dr. Sze's request by furnishing each of you who desires it a copy of a pamphlet containing two addresses of mine to engineering students in Spain and France, covering exactly that ground— and some more. My New York office at 35 Nassau Street will gladly mail to any of you who will write for it a complimentary copy of the said pamphlet.

And now, before closing this address, permit me to offer to each one and all of you the following words of advice:

When you return home you should at once go to work in the line or profession in which you have been trained; for every educated Chinese should contribute to the welfare of his country in the field of activity for which he is best equipped. Work always diligently, loyally, and faithfully; and do your best to uphold the reputation of China and to aid in placing her in the high position she should occupy among nations.

My best wishes for success, usefulness, and happiness go with you! Try to remember and utilize something of what I have said to you today; and if in the future anything should recall me to your memory, I trust that you will recollect me as, in every sense of the words, an ardent well-wisher and a faithful friend of the Chinese nation.

YOUNG MEN OF CHINA!—HARKEN TO ME AND HEED WHAT I SAY!

You yourselves have it in your power at this present moment to inaugurate a movement that ultimately would deliver your country from the bonds which now enthrall her and would place her where she belongs amongst the leading nations of the world!

Have you the desire, the energy, the courage to make the attempt?

You have heard me describe my project for the regeneration of China by means of a patriotic confraternity. Are you willing to be the original organizers of that society?

If so, get together whilst you are still here in Providence and form it, then after your return to China you can perfect the organization and start its functioning. Don't waste an hour in making a beginning, but assemble, resolve in meeting to proceed, declare yourselves as a society, give it an appropriate name, appoint a committee for the preparation of a Constitution, adjourn till a fixed time for receiving the Committee's report, reconvene, adopt the said Constitution, administer the oath to each member individually, appoint other committees to lay out a working schedule and the necessary details of development, arrange a program for future meetings, and thereafter, whilst you are in America, put in all the time you can spare from your studies and your work upon the elaboration of the said program, and the materialization of the Society, to the end that a few years hence, upon the return of some of you to China, you may inaugurate the functioning of the brotherhood and the accomplishment of some of its principal aims and objects.

You all probably know that I am slated to address a joint meeting of your Science and Engineering Societies three days hence. If it be your pleasure, I would gladly remain here till then and spend the time in aiding you to effect the suggested organization.

Ladies and Gentlemen, permit me most sincerely to thank you for your kind and steadfast attention to my possibly too-lengthy and ultra-drastic discourse.

ADDENDUM.

Some of my hearers of the preceding address appear to have misunderstood certain portions of its contents. This is not surprising when one considers that they were listening to a rather rapidly delivered speech in a foreign tongue. It has struck me, therefore, that it would be well to write an addendum for the purpose of explaining the misunderstood points and suggesting a few ideas developed during my week's stay at the Conference.

Several appeared to think that the society I proposed is intended to be a secret one, but that idea is incorrect, because, as I stated in the address, the Constitution and By-Laws should be published from time to time in the Chinese papers, so as to keep the objects of the organization in the public eye. The meetings, however, if the Society ɹəʌǝ sı . to accomplish anything of importance, would have to be held behind closed doors. If the general public be allowed to attend the meetings, or if the policies of the organization be made known before they are either consummated or assured of success, the opponents of honest government might be able to thwart some important measures. Very few businesses are carried on by means of a blare of trumpets; and the proposed society, in a way, is a business organization, for its aim is to accomplish a number of much needed reforms.

Some of my hearers formed the impression that the proposed society would constitute a political party; but that is not so. It certainly would have to deal with political questions; but it would do so by means of bringing pressure to bear on existing officials, or sometimes by ousting them from office and substituting for them men pledged to support the principles of the Society. The organization should not tie up with any political party nor adopt any special political platform; but should deal singly with important measures as they arise, and it could have measures of its own introduced and passed. The power of the organization would soon be recognized by the politicians as an important factor with which they would have to deal; and they would soon learn to count upon its influence being invariably used for the public welfare and being opposed to graft and crookedness of every kind.

Some of those who heard me speak formed the idea that, in joining the proposed society, they would be pledging themselves actually to do the various things that I listed as possible objects of the organization, and expressed themselves as being unable to do them. That was not my idea at all—the members both as a body and individually should *use their influence* and employ every legitimate endeavor to have all such worthy objects accomplished. That is quite different from doing the said things themselves.

At one of the meetings of the Alliance I was asked by a lady-member the question as to whether it was my idea to exclude women from the Society; and I replied decidedly in the negative, stating that, if I had my way, in every civilized country of the world women would have, without exception, all the privileges that men enjoy. I believe that Chinese women would exert a powerful influence for good in the proposed organization, and that they would be able to help the men

very effectively in securing desired legislation and in the enforcement of laws tending to the betterment of the Chinese people.

There is a matter which, purposely, I did not mention publicly at the Conference, viz., that before going there I prepared a draft of a Constitution to be used as a guide or suggestion to those who would later undertake the task of preparing a temporary one for use in this country while the nucleus of the organization is being formed, and in China also until such time as a permanent constitution is evolved; and I left several copies of this draft with the officers of the Alliance. It is possible that it may be used without material change, for I gave the matter deep thought during its preparation.

Let me repeat what I said to a number of members of the Alliance—that if they wait until after their return to China to inaugurate the proposed movement, it will never be undertaken at all, because of individual dread of losing one's job or of offending high officials. Also let me emphasize my statement that the returned students are the only Chinese who either will or can undertake the formation of the Society. However, they should take in as quickly as possible all the truly-loyal Chinese of high standing now resident in America, who are willing to join and to pledge themselves, and later all such men and women in China who are known to be patriotic and reputable.

As Dr. McElroy pointed out, it would be bad policy to let the people of your country believe that this Society is simply a collection of those who have been educated abroad and who have imbibed foreign ideas and adopted foreign customs. It is impracticable to have it anything but an aristocratic organization, for all its members would have to be people of education and good social standing; nevertheless it is inadvisable to let the masses form the impression that it is either a mutual-admiration society or an alliance of aristocracy as opposed to the interests of the proletariat.

Candidly, no successful country can avoid having an "aristocracy of brains," as is evidenced by the present condition of Russia; but such an aristocracy should be truly devoted to the interests and welfare of the common people.

I am hoping that, in some manner or other, during the next twelve months a large but select nucleus of the proposed organization will be formed in this country, in order that ere long it may be carried to China and rapidly develop there, so as to become an immense power for the good of the Chinese nation.

ADDRESS No. 2

THE FUNCTIONS OF BOTH PURE AND APPLIED SCIENCE IN THE FUTURE DEVELOPMENT OF CHINA.

Ladies and Gentlemen:

It is a source of profound gratification to me to meet here today so many young persons who are going to play such an important part in the future development of the most populous and ancient country of the world. The kindly and complimentary letter of your worthy Secretary, Mr. Sarcey T. Chen, inviting me to address you, notwithstanding the fact that I had already been chosen as the speaker for one of your previous assemblies, gave me the assurance that my presence at your Convention was really desired and that my words of counsel would be appreciated. It is always a matter of deep satisfaction to me to feel that I can be of service, especially to scientists; consequently, in accepting Mr. Chen's invitation I was doing myself a true pleasure.

At the time his letter reached me, the manuscript of the address that I delivered three days ago was completed and being typed. As you know, it covered in a general way the subject of what is needed in China in the principal lines of engineering work; hence it will be necessary for me to resume a few of the topics of that address and expand my observations thereon by going more closely into detail. This I trust you will pardon; for I can promise you that, in what I am about to say, there will really be no repetition worth mentioning of my previous discourse.

Under ordinary conditions in an address of this nature I would deal at length with ethical subjects; but, for the reason given in my previous address, I shall touch upon that topic but slightly, if at all, preferring to have you learn my ideas of engineering ethics from the addresses to engineering students in Spain and France that I gave last year, and which have since been printed in Spanish, French, and English. As I stated at the other meeting, I shall gladly supply you with all the copies you need. If your demand be greater than my present supply, I shall have more copies printed; for I took the precaution to have the printer keep the type set up—a wise move, for I have found it necessary to issue, all told, twice as many copies as were originally printed. Let me advise each one of you to read and

re-read those addresses of mine; for they contain advice based upon the accumulated experience of a long and exceedingly busy professional career, and in them I have spoken frankly and from the heart. These lectures will be just about as useful to you Science students as to those of you who are studying engineering—in fact they should be of value to students in any line of learning. For instance, a physician friend of mine employed them when lecturing to his medical students.

The time at my disposal today can, therefore, be advantageously devoted to other subjects than ethics.

There is a feature of this meeting that gives me great satisfaction and which proves that you young Chinese are working in the right direction. I refer to the fact that it is a joint meeting of Pure Scientists and Engineers and the sixth of its kind that you have held. For many years I have been maintaining that a close combination of the devotees of pure science and those of applied science is essential to the maximum of accomplishment in world progress.

As long ago as 1904, I lectured upon the subject of "The Relations of Civil Engineering to Other Branches of Science." It was at a meeting of the International Congress of Arts and Science at the St. Louis Universal Exposition; and as, in all probability, not one of you has ever read a word of that address, I take the liberty of quoting from it somewhat at length for the purpose of showing you both the division and the connection between the two main groups of sciences, viz., "Pure" and "Applied."

"The 'Pure Sciences' include:

"1st. Those sciences which deal with numbers and the three dimensions in space, the line, the surface, and the volume, or in other words 'Mathematics.'

"2nd. Those Sciences which deal with inorganic matter, its origin, structure, metamorphoses, and properties; such as geology, petrology, chemistry, physics, mineralogy, geography, and astronomy.

"3rd. Those sciences which deal with the laws, structure, and life of organic matter; such as botany, zoology, entomology, anatomy, physiology, and anthropology.

"4th. The social sciences; such as political economy, sociology, philosophy, history, psychology, politics, jurisprudence, education, and religion.

" 'Applied Sciences' include:

"1st. Those which relate to the growth and health of organic matter; such as medicine, surgery, dentistry, hygiene, agriculture, floriculture, and horticulture.

"2nd. Those which deal with the transformation of forces and inorganic matter, viz., the various lines of engineering—civil, mechanical, electrical, mining, marine, chemical, metallurgical, architectural, etc.

"3rd. Those which relate to economics; such as industrial organizations and manufactures, transportation, commerce, exchange, and insurance." * * *

"The distinctions between the pure and the applied sciences are at times extremely difficult to draw, for one science often merges almost imperceptibly into one or more of the others.

"The groups of pure sciences that have been enumerated may be termed

"The Mathematical Sciences,

"The Physical Sciences,

"The Physiological Sciences, and

"The Social Sciences,

while the groups of applied sciences may be called

"The Organic Sciences,

"The Constructive Sciences, and

"The Economic Sciences.

"The terming of engineering the 'Constructive Science' is a happy conception, for engineering is truly and almost exclusively the science of construction. The functions of the engineer in all cases are either directly constructive or tend toward construction.

"The engineer has ever had a due appreciation of all the sciences, imagination to see practical possibilities for the results of their findings, and the common-sense power of applying them to his own use.

"Pure science (barring perhaps political economy) is not concerned with financial matters, and its devotees often look down with lofty disdain upon everything of a utilitarian nature, but engineering is certainly the science most directly concerned with the expenditure of money. The engineer is the practical man of the family of scientists. While he is sufficiently well informed to be able to go up into the clouds occasionally with his brethren, he is always judicious and comes to earth again. In all his thoughts, words, and acts he is primarily utilitarian. It is true that he bows down to the goddess of mathematics, but he always worships from afar. It is not to be denied that mathematics is the mainstay of engineering; nevertheless the true engineer pursues the subject only so far as it is of practical value, while the mathematician seeks new laws and further development of the science in the abstract. The engineer does not trouble himself to consider space of four dimensions, because there are too many things for him to do in the three-dimension space in which he lives. Non-Euclidian geometry is barred from his mind for a fuller understanding of the geometry which is of use to ordinary

mankind. The mathematician demonstrates that the triangle is the sole polygonal figure which cannot be distorted, while the engineer, recognizing the correctness of the principle, adopts it as the fundamental, elementary form for his trusses. The mathematician endeavors to stretch his imagination so as to grasp the infinite, but the engineer limits his field of action to finite, tangible matters.

"The geologist, purely studious, points out what he has deduced about the construction of the earth; but the engineer makes the mine pay.

"The chemist discovers certain facts about the effects of different elements in alloys; but the engineer works out and specifies a new material for his structures. Again, the chemist learns something about the action of clay combined with carbonate of lime when water is added, and from this discovery the engineer determines a way to produce hydraulic cement.

"The physicist evolves the theory of the expansive power of steam, and the engineer uses this knowledge in the development of the steam engine. Again, the physicist determines by both theory and experiment the laws governing the pressures exerted by liquids, and the engineer applies these laws to the construction of dams and ships.

"The botanist with his microscope studies the form and construction of woods, while the engineer by experimentation devises means to preserve his timber.

"The biologist points to bare facts that he has discovered, but the engineer grasps them and utilizes them for the purification of water supplies.

"In short, the aim of pure science is discovery, but the purpose of engineering is usefulness.

"The delvers in the mysterious laboratories, the mathematical gymnasts, the scholars poring over musty tomes of knowledge, are not understood by the work-a-day world, nor do they understand it. But between stands the engineer with keen and sympathetic appreciation of the value of the work of the one and a ready understanding of the needs and requirements of the other; and by his power of adaptability he grasps the problems presented, takes from the investigators their abstract results, and transforms them into practical usefulness for the world."

These relations of the two groups of sciences are of comparatively recent origin, and are rapidly becoming closer. Year by year engineering grows more complex and more important, consequently its needs are becoming more generally recognized by the investigator; and at the same time the engineer is increasingly dependent upon the work of the pure scientist.

You gentlemen, as students, have (possibly unwittingly) recognized this fact by holding joint meetings of the two groups; and I trust that in after years, during the practice of your various professions in China, you will not forget it, but will make it a custom to hold there, at least annually, joint meetings of your scientific and your technical societies; for much good will be sure to result from such assembling.

At a meeting of this kind it is generally expected that the speaker will give his hearers some good advice—at least the best that he can offer—and this is undoubtedly sound practice, notwithstanding the fact that the giving of counsel by the old to the young is too often about as effective as the pouring of water on a duck's back. Knowledge can be obtained in two ways: first, through the recorded experience of others, and, second, by individual personal experience. In the first it is secured by search, reading, and study; while in the second, it is too often obtained through wasted time, pecuniary expense, and grief. Although it is true that knowledge procured in the latter way is generally likely to be retained, while that secured in the former manner is too often forgotten, it is undoubtedly the case that, up to a certain point, second-hand information is the more reliable. For this reason it is advisable that the young profit to the greatest practicable extent from the experience of the old. Again, every investigator, before starting on any line of research, should learn all that has been discovered previously in that line, in order to save himself the useless labor of repeating experiments. To do this he must either make or have made for him a systematic search of all scientific or technical literature, as the case may be. Fortunately, our great scientific and technical libraries employ experts for this class of work; consequently, before beginning his proposed investigation, all that the scientist has to do is to send a written request to the proper society for a search to be made at his expense on such and such lines. Generally the enquirer is charged only for the actual time expended by the search-specialists; and, as their salaries are small, the expense of obtaining the desired information is seldom serious.

In offering you the various kinds of advice I have in mind, it will be necessary at first to deal with one of your groups, then with the other, and finally with both jointly; consequently I shall begin by addressing the Pure Scientists.

Strange to say, the first suggestion I have to make is that you bend your energies to the investigation of practical matters instead of those of an abstract nature. The reason I advise this is that by so doing you can better advance the interests of your country. The investigations of the strictly-pure scientists are made for the benefit of the entire world, while those of the practical scientists can

often be primarily in the interests of their own country, although eventually, perhaps, for the service of other nations.

It is related of a noted scientist that, after having completed to his own satisfaction a long and elaborate scientific investigation, he exclaimed, "Thank God! no one can ever make any practical use of that piece of work!" To my mind such a motivating idea is wholly incomprehensible. Everything anyone discovers should be put to practical use, if that be possible.

While abstract investigations are necessary for the progress of the world, there are in other countries than China plenty of intellectual men devoting their lives to that class of research; and you should keep in close touch with all their discoveries, each of you in his own specialty, and be content to utilize their findings. Such work, for the present at least, is too much in the nature of a luxury for China; hence it would be preferable that you confine your activities to eminently practical lines, finding out first what new special knowledge is needed by Chinese engineers, then proceeding by investigation to obtain it.

Do not deduce from this advice that I am a believer in the too prevalent but fundamentally-erroneous notion that the oriental mind is incapable of original research—just the contrary!—for I am of the opinion that it is in no respect inferior to the occidental mind. I came to that conclusion some forty years ago when I was teaching civil engineering in the Imperial University at Tokyo.

Soon after my arrival there numbers of my colleagues volunteered the statement that, while the Japanese certainly make good students, they are incapable of original thought. For a while I was inclined to believe the allegation, simply because it seemed to be the almost universal opinion of foreigners in Japan; but after about a year I became acquainted with the Japanese mentality and drew a different conclusion.

I well remember, on the occasion of a stag dinner at Tokyo, hearing the subject discussed, everyone apparently being in accord with the prevailing dogma, until I exploded a bomb at the table by remarking, "You chaps are making the mistake of your lives! You are underrating the Japanese intelligence! It is true today that the Japanese people are not originators; and there is good reason for it. They are turning all their energies to the absorption of occidental knowledge and have no time to spare for original research. Just wait until they have caught up with us by learning all we have to teach them, and you will see that they will investigate and discover for themselves! Naturally, it is going to require many years for them to overtake us, but some of you are going to live long enough to learn that I am right!" Everyone present disagreed with me, but the few

of them who are still living must now recognize that I was not mistaken! for, although the Japanese still pursue their old, wise policy of sending great numbers of their most intellectual men abroad to study the latest developments in their various specialties, they have shown in many ways their ability to originate and to carry out scientific investigations. For instance, during the Russo-Japanese War, Japanese physicians and surgeons showed the world how wounded soldiers could be quickly cured of their hurts, and how the army could be kept free from contagious diseases, thus setting the pace in that line of science for the rest of the world.

It was my good fortune to become really well acquainted with the Japanese mentality; and I am positive that it is in no whit lower than that of any other nation. It makes my blood boil to hear anyone speak of the Japanese as an inferior race; and I have had many a battle royal on that subject. I remember once an occidental engineer making a claim of that kind, and I have to confess I was discourteous enough to tell him that, as a student, he could not have lived a week in one of my Japanese classes; for the members thereof were capable of learning in a given time fully three times as much as the best American students—and that I knew whereof I spoke, because, before I went to Japan, I had taught Rational and Technical Mechanics at the Rensselaer Polytechnic Institute, then universally acknowledged to be the one great engineering school of America, but now, of course, one of many such.

The capacity for work of my Japanese students was surprising! During the four years of my stay at the Imperial University I was constantly augmenting the extent of their studies; and I never did really determine the limit of their capacity, for, like Oliver Twist, they were always asking for more. As an illustration, I might tell you that when I left Japan, family reasons necessitated my sailing some two months or more before the close of the academic year. I was excused by the University with the proviso that I should complete my work before leaving. To this suggestion I replied, "That is all right as far as I am concerned, but how about the students? Can they stand the strain?" The answer was, "Go ahead and never mind the students." This I did, and completed all the courses by the middle of April. The strangest part of my story, though, is to come. Soon after my Junior Class learned of the new program of studies, they came to me in a body and said, "Professor, we are sorry you are going to leave us, and as we don't know what kind of an instructor your successor is going to be, we would like you to give us before you go as much of the senior year's work as you can." The request simply staggered me, and I replied, "Great Scott, are not you fellows content with having six months' work crowded into less than four without trying to take on any more? I don't want to kill you!" To

which they answered, "Don't worry about that, Professor, just try us." I did; and they took two of the most difficult courses in Technical Mechanics of the senior year's work.

Most of those men rose to very high positions in governmental employ and became a credit to the engineering profession. One of them died last year at the head of the Home Department; but as he lived till well on towards sixty, I cannot blame myself for having shortened his life by overworking him when a student.

Whilst I was in China two years ago I set myself the problem of studying the comparative mentalities of the Chinese and the Japanese; and I came to the conclusion that, contrasting the highest types of both races, there is but little, if any, difference in the matter of mental acumen. As I did no teaching there, other than the delivering of lectures, I did not have an opportunity to learn the capacity of the best Chinese students for absorbing knowledge; hence in that particular I cannot compare the two races.

But to return to my subject of advice to you scientific students —do not let your ambition be to make for yourselves world-wide reputations as investigators and discoverers, but let your energies be devoted to working for the practical benefit of your country.

Do not base your national scientific society upon the lines of the *Académie des Sciences* of France, the acknowledged leader of scientific thought for the entire world, but be content with a more modest ambition. If you will examine a few issues of the *"Comptes Rendus"* of the *Académie,* you will comprehend my reason for giving you this advice; for you will find that most of the papers they contain are exceedingly abstract and abstruse, representing, it is true, the most advanced scientific thought of the world. Very few of their investigations, however, could be utilized in your task, which is the material advancement of China.

Some of you may remark that "if we adopt and rigidly pursue the policy you suggest, Chinese scientists will be shut out from attaining the high honor of admission to the *Académie des Sciences.*" Not so! For I myself, who am essentially a practical engineer, have been admitted to the ranks of that select organization—an honor which I assure you I prize beyond expression.

Do not construe this last advice of mine as a desire on my part to keep the Chinese from ultimately taking their place among nations as investigators and discoverers. Two or three generations hence your people possibly will have caught up to the rest of the world in respect to modern learning and material development, and then it will be time enough to compete as investigators with the other nationalities; but by that time you, my hearers, will have passed to the beyond. For that reason the advice I have given you is sound. In

following it you would by no means be acknowledging any claim that the Chinese are not originators, because your history shows that many of the principal inventions claimed by the occidentals, such, for instance, as gunpowder, were really evolved in China ages before they were known to the rest of the world.

And now a few words concerning each of the principal lines of pure science and their application to the needs of your country.

Chemistry is one of the most important branches thereof for China, in that its findings are so necessary to certain lines of engineering work, such as sanitation, metallurgy, water supply, and cement production, in addition to being indispensable for the improvement of many processes of manufacture of articles in common use—to say nothing of its applicability to military purposes. Those of you who are specializing in Chemistry will have busy careers as soon as China begins to be politically and financially stabilized.

The science of Agriculture is closely allied to that of Chemistry, in that soil analysis is one of its leading features. The study of plant life, which brings in the science of Botany, is also a department of the science of Agriculture; and the study of insects that are injurious to vegetation involves the science of Biology. I predict, however, that those of you who are specializing in Agriculture, which is beginning to be considered a branch of engineering, will find that your duties will involve more the study of what the scientists and engineers of other nations are doing than the making of new investigations of your own, although it is not improbable that the exhausted lands of China will demand many special experiments and researches in the line of agricultural science.

In the application of the sciences of Biology and Bacteriology much can be done for the benefit of China—for instance, in the purification of potable waters, the treatment of sewage to prevent the contamination of streams, and the destruction of insect pests that are prejudicial to people's health and even destructive of human life. Few persons recognize the extent to which the most prevalent ills of man are attributable to the bites of insects—for instance, one kind of mosquito transmits malaria and another that dreaded disease, yellow fever; the body-louse carries typhus; the flea is responsible for the bubonic plague, the hookworm causes serious intestinal trouble; and the bedbug is the sole natural means of inoculating the smallpox. Again, the common house-fly carries on its feet the germs of typhoid and deposits them on man's food. You see, therefore, that those of you who have specialized in these two lines have your life work cut out for you.

The three great controllers of world population are war, pestilence, and famine. If men should ever become so sane and sensible as to cause war to be a thing of the past (an object eminently desirable, but, I fear, almost impracticable of attainment), and if the scientists succeed in effectively controlling all epidemic diseases, over-population would result and famine would desolate the lands. The sole method of preventing such a catastrophe is scientific birth-control, an innovation looked upon by certain religious people with holy horror but by thoughtful persons with favor. Do not think for a moment that I would countenance such a crime as infanticide. That would be unnecessary, as perfectly legitimate and harmless control of conception would effect the object. I imagine, though, that the enforcing of a limit to the size of families would prove to be a most difficult undertaking in China for many years to come.

Let me recommend all of you who specialize in the lines of Biology and Bacteriology to follow closely the investigations of my good friend, Dr. Charles A. R. Campbell of San Antonio, Texas. It is he who discovered how to keep down the activity of the malarial mosquito by the propagation of their natural enemy, the bat, and that of the yellow fever mosquito by the protection of the eggs of the large insect known as the mosquito hawk, devil's darning-needle, or dragon fly. Again, it was he who first discovered that smallpox can be transmitted in one way only—by the bite of an infected bedbug, or of its congener, the flying bedbug. I could tell you many things of absorbing interest about the scientific investigations of Dr. Campbell and how he has had to struggle unaided against the adverse influences of ignorance, envy, and professional jealousy; but time will not permit—suffice it to say that, in my opinion, he is one of the most advanced of our American investigators and one of the greatest benefactors of the human race that ever lived. It will not be long, I trust, before the leading nations of the world will give him due credit for the splendid work he has done and is still doing, and will award him all the honor and glory that are his due.

In the lines of Geology and Mineralogy there is much to be done for the benefit of China, in that some of her mineral deposits are yet unexplored, and even many of those that are known to exist have not been exploited.

While, next to Mathematics, Physics is undoubtedly the science most essential to civil engineering, as far as China is concerned, it will be better, for a few decades at least, to leave this line of investigation to the university and college professors to occupy some of their spare time; because the discoveries that are constantly being made all over the world can, with very slight delay, be utilized by your

countrymen. Moreover, that science is already quite well developed, and hence does not need Chinese time and money for its further advancement.

The same remark applies also to the science of Mathematics, enough of which is now known to serve all of China's purposes for many years to come—hence it would be better to leave to other nationalities the further elaboration of that interesting subject, and not waste your valuable time in trying to make discoveries therein.

The science of Teaching, however, is one that China should by no means ignore, because general education is so backward in that country. For at least two generations it is going to be one of the most salient questions in the regeneration of China. Those of you who are specializing in that line of science should devote much thought to the question of how best can be introduced for the populace effective instruction in the essential elements of learning, viz., what are often termed in this country the three Rs. Again, attention should be paid to the study of Chinese mental characteristics, so as to learn the quickest and most efficacious method of imparting instruction to the children. Different peoples absorb learning in different manners; hence special study of race peculiarities becomes obligatory.

Do not forget that the main object in teaching advanced courses should be to force the pupils to think—and think clearly. Clear thinking is one of the most important desiderata in technical education—or, for that matter, in any line of learning.

Let me advise all of you who adopt technical teaching as a life work to affiliate yourselves with the Society for the Promotion of Engineering Education and to take part in all its activities, in any case by joining in the discussion of those memoirs in which you are specially interested, and concerning the subjects of which you have some ideas of your own.

To the sciences of Geography and Astronomy the Chinese, for many years yet, need pay but little attention, excepting, of course, that they should be given due recognition in all institutions of learning; but there is very little in them of practical value for the development of your country.

Distinction should be drawn between the science of Economics and that of Political Economy. The former, strictly speaking, pertains to applied science and not to pure science, hence it will be treated later on; but the science of political economy is one that is of the utmost importance to the welfare of any country, hence it should be studied thoroughly, and its precepts should be practiced by the governing class of China, because it applies to all the inhabitants and

to all their activities. What are the limits of the ground it covers, or should cover, would be hard to say; but it is not going too far to state that its application is ubiquitous.

In connection with this subject, I should like to offer the suggestion that a national debt of reasonable amount is not a bad thing for any country, provided that the money borrowed be honestly and wisely expended. Such money makes work for the people and permits them to pay taxes, which are needed for still further development. Moreover, the knowledge of the fact that interest has constantly to be paid on such a debt is, or should be, an incentive for the people to work harder.

Some of you may say, "Why force the poor people to work hard, have they not trouble enough to bear as it is?" To that question I would reply that work is truly a blessing to mankind and not a curse, as many people think, and that every man should learn to love his work and take a pride in its successful accomplishment. This principle should be thoroughly instilled into the mind of every pupil and student in China!

In respect to the most feasible way in which your country may be developed, students of political economy should study the history of Japan during the last seventy years, in which time that country has changed from its ancient civilization to the one which now prevails there, viz., approximately that of the occidental nations. The progress made in those seven decades is something truly wonderful; and the Chinese could advantageously pattern therefrom, taking advantage, of course, of any economic mistakes that may have been made in doing the said development. It may sound to some of you like heresy on my part to say so; but I am of the opinion that the future of China is going to be very closely bound up with that of Japan, and that the two nations are going to work together amicably for each other's welfare. Such certainly would be the logical method of procedure for two neighboring oriental races that are so similar in many respects, but, of course, different in others.

The science of Jurisprudence is one of vital importance to the Chinese. From all I can learn, the laws of your country leave much to be desired; and, as progress there augments, numerous and fundamental modifications of the law will be constantly necessitated; hence those of you who are specializing in that branch of science need not anticipate leading an idle existence. While it will be necessary to study the laws of some of the most advanced countries before codifying your own, you will undoubtedly discover that many special rulings peculiar to China and conforming to her long-established customs will be necessitated.

These remarks bring to a close the advice I have to offer specially to the Science students; and I shall now proceed to deal with matters relating to Engineering.

The first advice I have to tender you Engineering students is that, as quickly as possible, you join the American Society of Civil Engineers. You can become Juniors immediately after graduation, then five or six years later Associate Members, and finally in about as many more years full members. There are, all told, in China sixty-six members in the various grades; but only twenty-three of these are Chinese, and only two of the latter full members.

In Japan, out of a total membership of forty-three, thirty-eight are natives, and of these twenty are full members. This large representation is very pleasing to me, as I personally had considerable to do with its accomplishment. It is my hope that an equally good showing will be made ere long by China; and anything I can do to further that result will gladly be performed.

I advise you to join also the Chinese Institute of Engineers and the Association of Chinese and American Engineers, and to take as prominent a part as you can in their activities.

In dealing today with the different lines of engineering work that will have to be undertaken in the future in China, I could not make my remarks complete without repeating some of the things that I said three days ago in my first address; hence, as before stated, I shall make what I have to say supplementary to the contents of the said address.

In respect to railroading, I advise that you study American methods of construction, because the kind of railroads you need is almost identical with that which we have been building here—not, however, our pioneer railroads but those in our thickly settled districts. American railroads are more economically built and operated than those of European countries. In your Peking-Suiyuan Railway you followed American practice; and the result has been very satisfactory.

As for the details of railroading in general, with special application to China, I would state that in September, 1921, I delivered extemporaneously to The Chinese Railway Association, of which organization, by the way, I have the distinction of being an Honorary Member, an address entitled "Observations on Railroad Construction and Railroad Bridges." After I had finished its delivery as far as the limited time permitted, I was specially requested by His Excellency, Minister Yeh Kung-Cho, to put my remarks in writing and to elaborate them as much as possible, so as to leave behind me some

data of value to Chinese railroad engineers. This I did; and the Railway Department published the paper in pamphlet form. It consists of a fairly-full treatment in a general way of some of the most salient features of American railway practice; and, as I do not like to repeat myself when I can avoid doing so, I beg to refer you to that pamphlet instead of now dealing further with the question of how railroads can best be built in China.

Concerning how to build arterial motor highways, I advise you to follow the latest American practice. This you can do fairly well by reading the textbooks thereon and what is written on the subject in the engineering press of this country; but you can post yourselves on the very latest practice by procuring and studying the highway specifications issued by the various States. These are generally full and thorough; for under them are built annually many miles of roads.

As to the building of the cheaper roads that feed these arterial motor highways—before determining, for any district, the specifications therefor, you should settle in advance the kinds and probable amounts of travel that will pass over them and then be governed accordingly.

If the distance between the side-ditches of the highway be made great enough at the outset, it will be a comparatively simple matter to widen and thicken the macadam covering or to use it at any time as a base for some kind of pavement. Care should be taken in the construction of these cheaper roads to obtain your money's worth; because a little extra amount spent may cause the difference between good roads and bad roads.

The subject of Railroad Drainage you will find discussed at some length in the pamphlet last mentioned. Let me warn you against neglecting this important matter of construction; because, if you do, a storm may wash away some of your embankment, or a long-continued spell of wet weather may so saturate the roadbed and its base that the surface of the roadway will be ruined by the settlement of the supporting earth. Don't let any water stand in the side-ditches; but give them grade enough and make the bottom surface thereof so smooth and continuously pitched that the water will readily flow through them into the off-take drains. These remarks on drainage apply to highways as well as to railways.

In regard to tunnels, I surmise that comparatively few will be required for China, as the most densely populated parts consist of comparatively level land, and it is there where most of the railroads will be built; but there is sure to be some tunneling in the moun-

tains, especially on the remaining portion of the railway line between Wu Chang and Canton. The construction of tunnels through hard rock is a comparatively simple matter; through earth it is more difficult; but subaqueous tunneling is the most difficult of all. As far as I know, there are no tunnels of the last type now contemplated for China. For the two types first mentioned, you would probably find that native talent would suffice, but for any tunnel to be built beneath the bed of a stream or lake it would probably be necessary to import skilled technical assistance. Two or three decades ago English engineers led the Americans on subaqueous tunneling, and we had to import help from Great Britain on the building of the Hudson River tubes; but today there are no better tunnel specialists to be found anywhere in the world than certain engineers in that line who are located in New York City.

One of the principal difficulties in water works engineering in China would be the obtaining of a supply of water free from contamination; hence thorough purification would generally be necessary. There are so many cities (both large and small), towns, villages, and even country homes in America having water-works systems, that there is no disputing the fact that this is the country from which Chinese engineers should draw their inspiration in that branch of technics.

The matter of sewerage I treated at length in my previous lecture; but let me repeat the suggestion that Chinese engineers study the method of Dr. Beccari, and see how to adapt it for use in their country. I believe it will be found to give the best possible solution of your problem of sewage disposal.

In respect to structural-steel shops, there is one caution I would give you, viz., that you provide special shops for each class of manufacture, and not try to arrange any one shop for handling several classes thereof. To do the latter would be uneconomic, and, therefore, bad practice.

Concerning river conservancy and land protection in China, there is a difference of opinion among American engineers. It has been proposed to narrow the Yellow River to about one-sixth of its present width and straighten it, so as to force the stream to cut a deep channel all the way to the sea. This plan may look promising on paper; but, in my opinion, it is not feasible, owing to the immense difficulty and prohibitory expense in maintaining the shore-protection work against the force of the current. As in many places there is no hard bottom within reach, the shore work would certainly be undermined by a heavy flood.

China would do well, as soon as the necessary money is available, to secure the services of three experts on river conservancy and have them make a study, extending over several years, of the principal rivers that give trouble by overflow, so as to determine how best to provide against it and thus prevent the flooding of adjacent territory. At the same time other experts, working in harmony with them, could provide for both internal navigation and the irrigation of neighboring agricultural lands.

Power development and electric lighting should also be studied by a commission of experts; and they should call to their aid other experts who specialize in business economics, so as to determine what sources of power it would pay to develop, and where the product could be sold at a fair profit.

When the proper times arrive, similar expert commissions should be appointed to study the various mining resources of the country, all proposed new harbors, and the locations and types of important manufactories.

On several occasions of late years, in both speaking and writing, I have made the statement that the great engineers of the future are going to be those who study deeply the science of technical economics and apply it to all their constructions—and I now beg to repeat this for your benefit. Unfortunately, there are very few books of any great value treating of this important feature of engineering practice; but I hope that ere many years the example I set the profession in my "Economics of Bridgework" will be followed by specialists in other lines of technics. It is my belief that, if we had today a first-class treatise on the economics of each important engineering specialty, the status of our profession would be improved fully one hundred per cent. In a country like China where there is so much to be done and so little money with which to do it, the study and practice of engineering economics are obligatory. Let me again advise each one of you to study carefully every writing of value that he can find concerning this fundamentally-important subject.

The development of aesthetics in all engineering designs, while not a matter of vital necessity, is still one of great importance. Quite often it costs no more to make a structure appear pleasing to the eye than it does to make it ugly; but even if to beautify it does involve a small augmentation in cost, it generally pays to spend the additional money. Usually increased time, study, and labor on the part of the designer will secure better aesthetic results than the mere expenditure of additional money on the construction.

In designing buildings and elaborate city bridges for China, I advise, whenever it is practicable, that you adhere to the old Chinese architecture, some of which is exceedingly beautiful. This was done in the case of the Rockefeller Hospital at Peking, and the result there was eminently happy.

For aesthetics in reinforced-concrete-bridge building, let me recommend that you read Séjourné's *"Grandes Voutes,"* the most elaborately gotten-up book on bridges that has ever been published in any language. A study of its beautiful illustrations alone by any bridge designer would be well worth while, even if he were unable to read understandingly a single word of the French language.

These general remarks concerning the various lines of engineering, together with what I said on the same subject in my previous address, complete the advice I desire to give specially to the members of the Engineering Society. In what follows I shall address both societies jointly.

Most of you have probably read Mr. Frederick W. Stevens' address entitled "A Frank Discussion of China's Present Problems," published lately by The China Society of America. If any one of you has not done so, he should procure a copy of it and read it more than once; for its contents present the mature judgment of an exceedingly able man. In most of what Mr. Stevens says I agree, especially when he remarks that "International Control by the Powers, advocated by many, would end in a huge failure." In my opinion, any attempt to force foreign control upon China would be absolutely disastrous.

No foreign nation or aggregation of foreign nations has either a moral or a legal right to force a great country like China to accept a protectorate; and it is most unlikely that America would agree to such an arrangement. China should not only be given a chance to work out her own salvation, but also should be aided by the Great Powers whenever such aid is officially sought by the recognized government of the country.

Mr. Stevens says in his paper that China's three great curses are—

First. The worse-than-useless armies of a million or more men, which keep the country in turmoil.

Second. The growing use of narcotics.

Third. The prevailing corruption among the officials.

In respect to the first and third of these claims I can vouch, and I have already dealt with them in previous discourses. Concerning the existence of the second I had no ocular proof, nevertheless I had heard of it; and, consequently, I touched upon the topic in my address at Canton to the Young Men's Christian Association.

If the drug habit ever gets a strong hold on your people, your country will be wrecked and ruined, and its future condition will be far worse than that existing today. I, therefore, advise all of you to exert every possible influence to stamp out the evil.

Concerning what Mr. Stevens says about the practical and effective work of the Christian missionaries in China, my experience, as far as it goes, tends to confirm his statements. While it is true that, during my four-year sojourn in Japan some forty years ago, I did not form a very exalted opinion regarding the calibre, mentality, energy, unselfishness, or efficacy of most of the foreign missionaries there, and on that account became more or less prejudiced against their calling, I must now confess that the little I saw some two years ago of the American missionaries in China caused me materially to modify my former opinion. Whilst my wife and I were visiting Canton, we were thrown into close association with the faculty of Canton Christian College, and were given an opportunity to look over their work and see some of their accomplishments. We found them to be a highly intelligent, earnest, energetic, kindly, and devoted group of teachers; and their labors were certainly producing very effective and valuable results. I cannot speak too highly of those teachers or of the good work they are performing.

Nevertheless, as I stated three days ago in my first address to this Assembly, I do not favor the attempt to Christianize the oriental peoples, who already have good and satisfactory religions of their own. From the point of view of a practical man, I cannot see that Christianity has been of much benefit to the occidental races. It was a so-called Christian nation which nine years ago tried to set the world on fire and destroy the civilization of the globe, with the intention of substituting therefor a *kultur* operated by force of arms—and, what is more, it came within an ace of succeeding. Again, when one looks back into history, and notes the cruelties practiced by the Christian church in the Dark Ages, the terrors of the Spanish Inquisition, and the burning of witches not so very long ago in this country, he is constrained to ask the question, "In what way is Christianity superior to the religions of the Orient?"

My definition of religion is "A Theory of Existence, covering the Past, the Present, and the Future."

As for the Past, it is so enshrouded in a mist of superstition, mythology, bigotry, intolerance, and even wilful falsification of history that no reliance can be placed on its records—therefore, why worry about such an uncertainty?

As for the distant future, who can tell? In spite of all the claims of Sir Oliver Lodge and his brother spiritualists, there has as

yet been shown no proof, satisfactory to hardheaded scientists, that the dead can communicate with the living, or that there is any individual existence after death—so, again, why worry about such an uncertainty?

But as for the present and the immediate future—that is an entirely different matter. The human mind can clearly conceive of things as they are, and can note how certain conditions are unfavorable to humanity—also how they can be improved. To that end men for ages have been forming codes of ethics which are, or should be, the bases of all religions. These were founded by great philosophers of the past—men outstanding from their kind—such as Buddha, Confucius, and Christ. Their ethical teachings were all good, sound, and practical; and there does not seem to be much to choose between them; for they can all be reduced to the general principle that everyone should do the square deal by everybody else under all circumstances—in other words, the Golden Rule of the Christian doctrine. If all men and women were faithfully to put this precept into practice, what a fine place in which to live this world would be! But alas! humanity in general is not built that way. In my experience, I have noted that the altruistic and truly unselfish people generally, but not always, belong to the highly-educated class; and I think most observers will agree with me in this conclusion.

It is to general education, then, that we must look for improvement in the practice of ethics and the consequent amelioration of the conditions affecting the happiness of mankind; hence, in the imparting of instruction to children and youths, the principles of ethics should be thoroughly taught and constantly enforced.

In closing this discourse, I would urge each one of you to devote himself wholeheartedly to his duty in whatever line it may lie—in fact, let "Devotion to Duty" be your slogan throughout your entire career; and as a parting word permit me to offer you the following maxim:

THE HIGHEST POSSIBLE ATTAINMENT FOR ANYONE'S LIFE WORK IS TO BE OF REAL SERVICE TO HUMANITY!

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